

# Neurosurgery in the People's Republic of China: an Update

Ling Feng<sup>1,\*</sup>

<sup>1</sup>Department of Neurosurgery, Xuanwu Hospital, China International Neuroscience Institute, Capital Medical University, China

\*Corresponding author: Ling Feng, Department of Neurosurgery, Xuanwu Hospital, China International Neuroscience Institute, Capital Medical University, China. Tel: +86-1083198836, Fax: +86-1083163245, E-mail: ling-feng@vip.163.com

Received: February 1, 2015; Accepted: February 22, 2015

Keywords: Neurosurgery; China; History

## 1. Introduction

With the rapid development of Chinese economy, there has been tremendous advancement of neurosurgery in P. R. China in the last decade. In this review, we aim to provide an overview of these changes and present an update of every aspects of neurosurgery in our country.

## 2. Ancient Era

With thousands of years of continuous history, China is one of the oldest civilizations. As long as the history of Chinese culture, is the origin and evolution of neurosurgery in China. Similar to the evidence demonstrating the beginning of neurosurgery in western countries, there was skull trephination discovered on the skeletal remains of Dawenkou native people in China, which date back to approximately 5000 years ago. However, due to the lack of documentation, it is difficult to determine what instrumentation was employed to perform trephination in that era. The first craniotomy and neurosurgical procedure could be traced back to the Era of Three Kingdoms (AD222-280). According to that famous historical anecdote, Hua Tuo, an iconic physician at that time, was trying to surgically treat Cao Cao, King of Wei Kingdom, who suffered from severe headaches caused by a suspected brain tumor. Unfortunately, there is no formal detailed description of that process.

## 3. Emergence of Neurosurgery

In a very long period thereafter, Chinese traditional medicine and herbal drugs had dominated the health field in China. With the introduction of western medicine into China by a few modern medical pioneers about one century ago, neurosurgery, as one of the surgical subspecialties, started to take roots in Chinese medical soil (1). Dr. Song-Tao Guan, was one of the very few pioneer neurosurgeons in the early 1930s. After finishing his neurosurgery residency in Peking Union Medical College Hospital (PUMSH), a hospital established by the China

Medical Board in New York under the Rockefeller Foundation of the United States, Guan went to the United States to receive training under the mentorship of American neurosurgical pioneer Dr. Charles Harrison Frazier. In 1930, Dr. Guan returned back to Beijing and began to treat patients with brain injury and tumors. Two years later, Dr. Guan published the first neurosurgical paper in the English version of the Chinese Medical Journal, in which he described his experience with the subtotal resection of the sensory root of trigeminal nerve via a sub-temporal approach to treat trigeminal neuralgia (2). Another neurosurgery pioneer, Dr. Charles Chang, reported his experience of surgical removal of neurofibroma in trigeminal ganglion in 1935 (3).

Prof. Yi-Cheng Zhao, an iconic forefather, contributed significantly to the early development of modern neurosurgery in China. Born in Fujian Province of southern China, Prof. Zhao graduated from PUMC in 1934. Later, Prof. Zhao pursued his post-graduate neurosurgery training with Professor Wilder Penfield in the Montreal Neurological Institute affiliated to McGill University from 1938-1940, under the financial support provided by Rockefeller Foundation (4). Thereafter, Prof. Zhao returned back to China and joined Dr. Guan in PUMCH until the outbreak of World War II (5, 6).

## 4. Era of Modern Macro-Neurosurgery: From Chaos to Independence

After the foundation of new China in 1949, Dr. Guan left for the United States and Prof. Zhao began a new chapter of modern neurosurgery in China. Sponsored by the central government of China in 1952, Prof. Zhao established the first neurosurgery department in Tianjin General Hospital. Within two years, Prof. Zhao and his students treated 788 patients with various neurosurgical disorders including brain tumor (183 cases), brain trauma (166 cases), trigeminal neuralgia (58 cases) and spinal diseases (58 cases). In 1953, Prof. Zhao initiated formal neurosur-

gery training programs in China for two durations of one year and half a year. The half-a-year program focused on management of trauma, while the one-year-program emphasized on the treatment of tumors. More than twenty-three participants who were already skilled general surgeons from different parts of China received training in the program (7). Students of Zhao at that time included Prof. Chungcheng Wang, Prof. Qingceng Xue and many others, who later became the backbone of modern neurosurgery of China and leaders of neurosurgery in their own fields (8).

In 1954, due to the collaborative relationship between China and the former Soviet Union, Prof. A.E. Arutiunov (director of the Kiev Neurosurgical Institute) was sent to China to help train neurosurgeons. Prof. Y. C. Zhao was also required by the central government to join this mission. Therefore, Prof. Zhao left for Beijing and his student Prof. Qingcheng Xue succeeded him eventually in Tianjin General Hospital. Arutiunov and Zhao together set up a training program and neurosurgery department, first in an affiliated hospital of PUMHC, then moved to Tongren Hospital, both in Beijing (9-11). Due to the increased number of patients, Prof. Y. C. Zhao eventually decided to move this neurosurgical department to Beijing Xuanwu Hospital.

In Xuanwu Hospital, Prof. Zhao established the Beijing Neurosurgical Research Institute (in 1960), the first institute dedicated exclusively to the research on neurosurgery in China. There were four laboratories within this research institute, including neuropathology, neuro-chemistry, neuro-physiology, cell and tissue culture. Many important research works were accomplished by this institute. To name a few, the first glioma cell line G422 which was originally established and continues to be used today, the animal model for brain edema and Parkinson's disease (12-15). The clinical service led by Prof. Zhao continued to expand with the bed number increased to 120. For a long period thereafter, the neurosurgery department in Xuanwu hospital became the academic and clinical neurosurgical center of China. After Prof. Zhao's death, his student Prof. C.C. Wang succeeded him as the director of the neurosurgery department and Beijing Neurosurgical Research Institute in 1974. Due to the increasing number of patients, C.C. Wang decided to move to the Beijing Tiantan Hospital, together with the research institute in 1982. Prof. Wang subsequently built the neurosurgery department of Beijing Tiantan Hospital into one of the major neurosurgical centers in China. The Beijing Neurosurgical Research Institute was expanded to hold 11 laboratories. After Wang's leaving, the neurosurgery department of Xuanwu Hospital was chaired by Prof. Yu-Ji Ding and then the author of this paper, Prof. LING Feng, till now.

Neurosurgery also gained substantial progress in other parts of China. Shanghai, as one of the major cities in China, became another major hub of neurosurgery in eastern China. Prof. Yu-Quan Shi and James Ke-fei Shen jointly

established independent neurosurgery departments in Chung-Shan Hospital. In 1953, they moved this neurosurgery department to the First Red Cross Hospital which subsequently transformed into the Shanghai Huashan Hospital. In 1980s, Shanghai Neurosurgical Research Institute was established and headed by Prof. Shi. Under his leadership, both the neurosurgical department and research institute grew rapidly. Prof. Shi was famous mostly for his work in cerebral vascular surgery. In addition to other pioneering works, he performed the first surgical clipping for aneurysm in China (16). Prof. Y. Q. Shi was subsequently succeeded by Prof. Da-Jie Jiang and later Prof. Liang-Fu Zhou. In other regions of China, neurosurgery departments were also founded, firstly in the capital city of each province, later in other minor cities. The above mentioned history was also partly reviewed by Y. L. Zhao and Y. D. Zhao (17).

## 5. Era of Micro-Neurosurgery in China: Current Picture

With the introduction of microscope and the philosophy of minimal invasiveness into neurosurgery by Prof. Yasargil, neurosurgery in China entered the era of micro-neurosurgery, approximately 5 years behind its western counterparts (18-20). At this time, the first STA-MCA bypass surgery was performed by Dr. Ren-He Zang from the First Hospital affiliated to Xinjiang Medical University (21). Most capital cities in each province have their own neurosurgical centers equipped with complete micro-neurosurgical sets including MRI, DSA, PET, microscope and neuron-navigation system (22-24). Since the reform and open-up in China, many Chinese neurosurgeons have been sponsored by the government to receive further training overseas in world renowned neurosurgical centers, such as the International Neuroscience Institute Hannover (INI-Hannover), Barrow's institute, etc. Meanwhile, many neurosurgery iconic figures such as Prof. M. Samii and Prof. M. G. Yasargil, were invited to China to give lectures, perform surgery demonstrations and hold educational courses. The voluminous milestone books of Microneurosurgery (edited by Yasargil) and Skull Base Surgery (edited by M. Samii) were even translated into Chinese by the author of this paper (LING Feng) (25-28). Thanks largely to these contributions, the Chinese neurosurgery is able to keep close pace with the world neurosurgery. I will try to overview the development of micro-neurosurgery in every sub-specialty.

## 6. Brain Tumors

Most brain tumors would be managed by neurosurgeons first. Multimodal facilities will be employed for the resection, which includes neuro-navigation, intra-operative ultrasound, endoscope, ultra-sound suction, etc. There are more than ten intra-operative MRIs in China. However, 5-ALA, the drug to visualize high grade glioma through fluorescence, is not available in China. The majority of brain tumors could be safely removed, in-

cluding tumors of sellar region, basilar ganglion region, thalamus, CPA, and even brain stem. However, multi-discipline brain tumor board is not routinely set up in most neurosurgical departments in China. Patients with brain tumors will seek help from each individual specialist. Personalized treatment for patients with brain tumors is still not popular in China (29-33).

## 7. Cerebral Vascular Diseases

Most aneurysms and AVMs could either be surgically clipped, embolized, or treated in combination with these two modalities. For ischemic cerebral vascular disease, procedures of stenting, bypass surgery and CAS are common in most neurosurgical centers (34-37). However, for cerebral vascular diseases, the selections of appropriate procedure sometimes may not best suite the patients' situations. This is often due to the difference in physician's skill and preference. As pioneering founders, Professor Cheng-Ji Liu and her student Prof. LING made significant contributions to the progress of Chinese cerebral vascular neurosurgery. Prof. C. J. Liu published *Cerebral Vascular Surgery and Interventional Therapy* and *Cerebral and Spinal Vascular Surgery*, which paved the critical foundation for the Chinese cerebral vascular neurosurgery (38, 39). In 1982, Prof. LING Feng went to Paris and received the training under the mentorship of world renowned interventionalist Prof. J. J. Merland. After her return, LING Feng introduced interventional neuroradiology into China and held many training courses. She was the chief author of *Interventional Neuroradiology and Imaging of Interventional Neuroradiology* which have become the textbooks for neurointerventionalists in China. Prof. LING further established the Postgraduate School of Neurointervention affiliated to the Capital Medical University, the first of its kind in the world. Under her mentorship and training, many neurosurgeons are fostered into both a cerebral vascular surgeon and neurointerventionalist, who later have become the backbone of the Chinese cerebral vascular neurosurgery (40-42).

## 8. Spinal Neurosurgery

For a long period, spinal disease was mainly managed by orthopedists. Neurosurgeons only dealt with disease involving the spinal cord. Since the last one or two decades, neurosurgeons have begun to treat cervical diseases, such as disc herniation, etc. Both patients with spinal disease and neurosurgeons in China have started to realize that with microscope these disorders would seemingly be managed better (43).

## 9. Other Specialities

Traditional functional disorders including epilepsy, Parkinson's disease and trigeminal neuralgia can be treated by functional neurosurgery specialist nowadays. The main issue for patients with functional neurosurgery diseases in China resides in the surgical indication and selection of right procedures (44). Pediatric neurosur-

gery has been practiced only in the neurosurgery departments of major hospitals in China. There are very few neurosurgeons specialized in peripheral nerve neurosurgery (45). Brain trauma is a common disease in China, similar to other countries. Trauma surgery is the most common procedure performed by neurosurgeons in the county hospitals (46). Most neurosurgery departments are associated with intensive care units in China.

## 10. Neurosurgical Training: Education and Accreditation

Currently, there are more than ten thousand practicing neurosurgeons in China. However, until now, there is no universal and formal neurosurgery residency and fellowship training program in China. Usually, the medical graduates will undergo one to three years' rotation in other surgery specialities including general surgery, urology, cardiac and thoracic surgery and orthopedic surgery before they could enter the neurosurgery department. And then, the residency training for them varies from five to ten years, which largely depends on the regulation of their own neurosurgery departments. As for the fellowship, most neurosurgeons (mostly attendants) will go to the major neurosurgical centers to receive another one to two years' training (47). Beginning from 2015, thanks to the efforts of the Congress of Chinese Neurological Surgeons, there will be a standard formal neurosurgery residency training in China. This seven-year-residency training program will include rotation in sub-specialities of brain trauma, brain tumor, cerebral vascular disease, spinal disease, skull base, pediatric neurosurgery and functional neurosurgery, etc. There will be around one hundred neurosurgery residency training programs throughout China, providing two to three hundred positions annually in total. Only those who have passed the exams after the training program will be accredited with license.

## 11. Chinese Neurosurgical Society and Congress of Chinese Neurological Surgeons, Both Members of WFNS

In 1986, the first neurosurgical association, the Chinese Neurosurgical Society, was created, mainly due to the advocacy and efforts of C.C. Wang who also assumed the first presidency. Another neurosurgical society, the Congress of Chinese Neurological Surgeons (CCNS), was established in 2004, which also elected C.C. Wang as the first president. The main duty for Chinese Neurosurgical Society is academic affairs of Chinese neurosurgery, while the major responsibility of CCNS is to deal with issues concerning the training, education, self-regulation and rights protection of Chinese neurosurgeons. The term for the president and committee of both bodies is three years. The current presidents of CCNS and Chinese Neurosurgical Society are Prof. LING Feng (Xuanwu Hospital) and Prof. Jian-Ning Zhang (Tianjin General Hospital), respectively (48).

## 12. Neuroscience Funding, Research and Journals

The funding source for neurosurgery in China mainly comes from central and local government. Financial support from charity foundation and hospital for neurosurgical research is very rare. On one hand, compared to western counterparts, the investment in research for neurosurgery is still low. On the other hand, neurosurgeons in China do not have enough time and laboratory space to conduct research. Up to now, there are more than ten neurosurgical medical journals in China. More than five thousands neurosurgical papers are published annually in Chinese neurosurgical journals and other foreign journals. However, high impact papers are still very few (49).

## 13. The Future

With the further reform and opening up of China, there will be corresponding adjustment and changes in the healthcare field in terms of the policy and management system. With the permission of private investment into the medical field, better executive mechanism of healthcare will be expected, which in turn may lead to more funding for clinical research and translational medicine. The main mission of CCNS aims to narrow the gap of neurosurgery between different regions, thus raising the average level of neurosurgery throughout the country. Eventually, this will benefit patients with neurosurgical disorders in a country with  $\frac{1}{4}$  of the population on earth.

## References

- Chen Y, Zhang ZX. Establishment of Western Medicine Education in Modern China. *Chinese J Northwest Med Edu*. 2008;**16**:1-3.
- Kwan ST. Trigeminal neuralgia: Diagnosis and treatment. *Chin Med J*. 1932;**46**:260-76.
- Chang C. Neurofibroma of the gasserian ganglion. *Chin Med J*. 1935;**49**:412-21.
- Chao YC, Humphreys S, Penfield W. A New Method of preventing Adhesions. The Use of Amnioplastin after Craniotomy. *Br Med J*. 1940;**1**(4134):517-538 1.
- Zhao KM, Zhao YD. Yi-Cheng Zhao: a founder of neurosurgery in China. *Neurosurgery*. 1997;**41**(1):259-61.
- Xue QC. Professor Zhao Yicheng: Pioneer of neurosurgery in New China. *Chin J Neurosurg*. 1987;**3**:1-2.
- Zhao YC. Brief history of early Chinese neurosurgery. *Chinese J Neurosurg*. 2013;**29**:217-20.
- Yang SY. Perspectives in international neurosurgery: neurosurgery in Tianjin, China. *Neurosurgery*. 1982;**11**(6):816-7.
- Zhao YC. Progress of neurosurgery in China. *Chin J Surg*. 1954;**3**:210-1.
- Zhao YC. Achievement in neurosurgery in New China. *Chin J Surg*. 1959;**7**:889-90.
- Zhao YC. Neurology, neurosurgery and psychiatry in New China. *Chin Med J*. 1965;**84**:714-24.
- Cheng YX, Li F, Lu JY, Li M, Du P, Xu GL, et al. Growth of G422 glioma implanted in the mouse brain was affected by the immune ability of the host. *Chin Med J (Engl)*. 2011;**124**(13):1994-8.
- Ma YH, Yu JB, Yao HP, Zhan RY, Zheng JS. Treatment of intracerebral glioblastomas with G422 tumour cell vaccine in a mouse model. *J Int Med Res*. 2008;**36**(2):308-13.
- Wang H, Tu HJ, Qin J, Li XJ, Huang KM, Zhou ZM, et al. [Effect of cryotherapy and 5-fluorouracil on apoptosis of G422 glioma cells]. *Ai Zheng*. 2004;**23**(4):412-5.
- Li F, Cheng Y, Lu J, Hu R, Wan Q, Feng H. Photodynamic therapy boosts anti-glioma immunity in mice: a dependence on the activities of T cells and complement C3. *J Cell Biochem*. 2011;**112**(10):3035-43.
- Shi YQ. Operative treatment of intracranial aneurysms. *Chin J Surg*. 1961;**9**:189-92.
- Zhao YD, Zhao Y. Neurosurgery in the People's Republic of China: a century's review. *Neurosurgery*. 2002;**51**(2):468-76.
- Tew JJ. M. Gazi Yasargil: Neurosurgery's man of the century. *Neurosurgery*. 1999;**45**(5):1010-4.
- Yasargil MG. Personal considerations on the history of micro-neurosurgery. *J Neurosurg*. 2010;**112**(6):1163-75.
- Yasargil MG. A legacy of microneurosurgery: memoirs, lessons, and axioms. *Neurosurgery*. 1999;**45**(5):1025-92.
- Zang RH, Liu WY, Wu J. Intra-extra cranial bypass surgery to treat ischemic cerebral vascular disease. *Chinese Journal of Surgery*. 1978;**16**:19-21.
- Liu ZL. Current status of minimal invasive neurosurgery in China. *J Foreign Med Sci*. 2003;**30**:571-6.
- Zhao JZ. The current situation and future progress of Microneurosurgery in China. *Chin J of Microsurg*. 2005;**28**:97-8.
- Li LH, Qin HZ, Hou WH. Intraoperative Sonography-guided Microsurgery for Resection of Intracranial Lesions. *Chin J of Clin Neurosurg*. 2009;**14**:93-5.
- Yaşargil MG, Abernathy CD. *Microneurosurgery*. Thieme; 1996.
- Samii M. *Surgery of the skull base*. Germany: Springer publisher; 1989.
- Ling F. *Microneurosurgery (Chin Translation)*. China: Scientific and Technological Publisher; 2001.
- Ling F. *Surgery of the skull base (Chin Translation)*. China: Scientific and Technological Publisher; 2008.
- Chang L, Su J, Jia X, Ren H. Treating malignant glioma in Chinese patients: update on temozolomide. *Oncol Targets Ther*. 2014;**7**:235-44.
- Chen LH. Current progress on the radiotherapy of brain tumor. *Chin J of Neuro-onco*. 2004;**2**:79-81.
- Chen L, Zou X, Wang Y, Mao Y, Zhou L. Central nervous system tumors: a single center pathology review of 34,140 cases over 60 years. *BMC Clin Pathol*. 2013;**13**(1):14.
- Wu JS, Zhang J, Zhuang DX, Yao CJ, Qiu TM, Lu JF, et al. Current status of cerebral glioma surgery in China. *Chin Med J (Engl)*. 2011;**124**(17):2569-77.
- Huang L, You G, Jiang T, Li G, Li S, Wang Z. Correlation between tumor-related seizures and molecular genetic profile in 103 Chinese patients with low-grade gliomas: a preliminary study. *J Neurol Sci*. 2011;**302**(1-2):63-7.
- Zhang SM, Qu Q, Mei AN. retrospective and prospective on the prevention and treatment of cerebral vascular disease in China. *Chin J of Neuro-onco*. 2005;**38**:140-4.
- Pi Y, Zhang L, Yang Q, Li B, Fang C, Gao C, et al. Neurothrombectomy for the treatment of acute ischemic stroke in 1530 patients. *J Clin Neurosci*. 2012;**19**(10):1363-8.
- Zhao YL. Progress of cerebral vascular surgery on 2009. *Chin J of Stroke*. 2009;**8**:67-8.
- Liu CJ. Retrospective and Prospective on the cerebral vascular surgery. *Chin J of Neurosurg Dis Res*. 2002;**28**:9-92.
- Liu CJ. *Cerebrovascular Surgery*. Nanjing. China: Scientific and Technological Publisher; 2000.
- Liu CJ. *Cerebral and Spinal Vascular Surgery*. Nanjing. China: Scientific and Technological Publisher; 2014.
- Ling F. Progress on the treatment of cerebral vascular disease. *Chin J of Neurosurg*. 1997;**13**(1).
- Zhao E. Dr Ling Feng A heroine from the world of neurosurgery. *Woman of China*. 2002;**8**(1).
- Feng L. A dancer on the tip of the scapel. *Chin J of Capital Med Uni*. 2009;**30**:407-4408.
- Bao SD. Progress of spinal neurosurgery. *Chin J Min invas neurosurg*. 2005;**10**:385-8.
- Sun BM. Current status of functional neurosurgery. *Chin J Min invas neurosurg*. 2011;**16**:49-50.
- Xu L, Yi B, Yu X. Progress and prospective on peripheral nerve neurosurgery. *Chin J Modern Med*. 2001:31-4.
- Zhang XN, Zhang H. Progress on the treatment of traumatic brain injury. *Chin J Rehabil Theory Prac*. 2008;**14**:101-4.
- Weinstein PR, Newfield P, Alker G, Glasauer F, Kaufman H. Neurosurgery in a different society: the People's Republic of China. *Neurosurgery*. 1982;**10**(3):401-8.
- Editorial. Introduction of the Chinese Congress of Neurological Surgeons. *Chin J Neurosurg Dis Res*. 2005;**5**:1.
- Liu BY. Fostering of the ability of research for neurosurgery graduate residents. *Chin J Capital Med Uni*. 2007;**7**:158-60.